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UNCLASSIFIED INFORMATION ON SOVIET BLOC INTERNATIONAL GEOPHYSICAL COOPERATION -1960

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INFORMATION ON INTERNATIONAL GEOPHYSICAL COOPERATION --

SOVIET-BLOC ACTIVITIES

Table of Contents | Page

I. ROCKETS AND ARTIFICIAL EARTH SATELLITES

"Pravda" Salutes the End of the Third Artificial Satellite

The following brief notice appeared on page 4 of Pravda on 9 April:

On 6 April 1960 the third Soviet artificial earth satellite, launched on 15 May 1958, entered dense layers of the atmosphere and ceased to exist. The satellite was in orbit for 691 days and during that period covered 448 million kilometers.

The last radio signals from the third satellite were received by observing stations situated within the Soviet Union on the morning of 6 April on the satellite's 10,035th revolution around the Earth. The signals were recorded up to the moment of its departure from the zone of visibility of the USSR observation network.

On the basis of computations and in accordance with data relative to the last observations, made in the Western Hemisphere, the satellite ceased to exist on its 10,037th revolution, during which its period of revolution was about 87 minutes.

The planned program of research and measurements has been completely accomplished. ("The Third Satellite Has Ceased Its Existence," Pravda, 9 April 1960, p. 4)

Soviet Postmark Honors the Third Satellite

The following notice appeared in Pravda on the same day the third Soviet sputnik made its last revolution around the Earth, but before news of this event reached the Soviet Union:

The third Soviet artificial earth satellite has now completed its 10,000th revolution around the Earth. The Ministry of Communications of the USSR has authorized a special commemorative postmark in honor of this event. The postmark shows the Earth and the outlines of the third satellite with the inscription "USSR-3 -- 10,000 revolutions." Beside this is the text: "Third Soviet Earth Satellite. Moscow -- April 1960."

This postmark is being used for the cancellation of stamps at the main post office and the central telegraph building in Moscow and also in Leningrad, Kiyev, Minsk and several other cities in the Soviet Union. ("In Honor of the Third Satellite," Pravda, 6 April 1960, p.6)

Czech Academy of Sciences Tracking Sputnik III

The lifetimes of the Soviet artificial earth satellites, Sputniks I, II, and III, are discussed in an article by Prof. Rudolf Pesek, Corresponding Member of the Czechoslovak Academy of Sciences written for Obrana Lidu. In explaining the reasons for the decay of the satellites' orbits, Prof. Pesek states that "according to the computations of the Czechoslovak Academy of Sciences observatory at Ondrejov, Sputnik III will burn up in the upper atmosphere sometime between 10 and 19 April."

Prof. Pesek reveals that the Institute of Radio Technology and Electronics (Ustav radiotechniky a elektroniky) of the Czechoslovak Academy of Sciences has conducted systematic daily radio observations of Sputnik III since 17 May 1958 and has obtained one of the most complete tracking records of this Soviet satellite. ("10,000 Times Around the Earth," by Prof. Rudolf Pesek, Corresponding Member of the Academy of Sciences; Prague, Obrana Lidu, 27 March 1960, p 1)

II. UPPER ATMOSPHERE

Some Data on the Polarization of Atmospheric Light -- Full Text of a Report in "Doklady Akademii Nauk SSSR"

The author made observations of the brightness and polarization of a clear sky along the circle of altitude of the Sun at the mountain observatory of the Astrophysical Institute of the Academy of Sciences of the Kazakh SSR in the outskirts of Alma-Ata (elevation: 1,450 meters) in August 1956, at the Aksengerskiy state farm on the outskirts of Alma-Ata (elevation: 500 meters) in June-July 1957, and in the Libian Desert of the Egyptian portion of the United Arab Republic (elevation: 200 meters) in October-November 1957. The observations were made by using a visual photometer with a yellow Schott filter.

We used the method devised by V. G. Fesenkov to determine polarization; in this method the brightness of the investigated point in the sky is measured through the polaroid in its three positions, each 60° distant from one another. By using this method it was possible to determine the degree of polarization and the orientation of the plane of polarization. The degree of polarization P (ϑ) was determined by the formula:

$$P(\vartheta) = \frac{2\sqrt{B_1(B_1 - B_2) + B_2(B_2 - B_3) + B_3(B_3 - B_1)}}{B_1 + B_2 + B_3}, \quad (1)$$

where B_1, B_2, B_3 -- the brightness of the observed point in the sky with the polaroid in the three indicated positions.

As is well known, the degree of polarization in a pure dry atmosphere $P_R(\vartheta)$, in accordance with Rayleigh, is expressed in the following form (without taking into consideration the anisotropy of molecules):

$$P_R(\vartheta) = \frac{\sin^2\vartheta}{1 + \cos^2\vartheta}, \quad (2)$$

where ϑ -- the angle of scattering.

We discovered that on several days in the real atmosphere the influence of aerosols on the degree of polarization P (ϑ) was expressed only by some decrease in $P_R(\vartheta)$ in one and the same respect for all angles of scattering ϑ. Thus, for these days:

$$P(\vartheta) = kP_R(\vartheta), \quad (3)$$

where k -- the maximum degree of polarization on the circle of altitude of the Sun (for $\vartheta = 90^{\circ}$).

Such a proportionality does not depend on the transparency of the atmosphere. In some cases the dependence of P (ϑ) on ϑ is expressed quite precisely by equation (3) even when the transparency of the atmosphere is very bad; in other cases, however, even with high transparency,

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such a dependence differs somewhat from that which is described by this expression. As an example, two sketches are provided. They show that the observed degree of polarization is rather well satisfied by expression (3). These sketches illustrate days with high (Figure 1) and low (Figure 2) atmospheric transparency. In addition, Figure 3 shows a case where the curve of distribution P (ϑ) differs (although to a small degree) from that which is given by expression (3), despite a high transparency of the atmosphere, and the curve proves to be steeper. In all three sketches the a points represent the values of P (ϑ), derived from observations, b -- the values computed from expression (3). The multiplier k of the expression is equal to 0.685, 0.325 and 0.742 respectively.

The points of Figure 1 were derived from observations made on 6 August 1956 before noon at the mountain observatory when the coefficient of transparency was p = 0.88. The curve is the mean of two curves, determined successively, when zenith distances of the Sun were z = 69°-58°.

The points in Figure 2 pertain to 16 August 1956 before noon (mountain observatory), when p = 0.57; a strong dry haze was observed and the sky was an exceedingly pale blue color. This curve is also the mean of two curves, determined successively when z = 54°-50°.

The points in Figure 3 were derived from observations of 10 November 1957 before noon in Egypt when p = 0.88, z = 80°-73°. The sky was cloudless on these three days. In calculating the anisotropy of molecules by the Kabanna method the Rayleigh formula (2) is replaced by the expression:

$$P_{R-C}(\vartheta) = (1 - a)\,\frac{\sin^2\vartheta}{1 + \cos^2\vartheta + a\sin^2\vartheta}\,, \qquad (4)$$

where a -- a depolarization factor. For air a = 0.0415, or according to measurements by de Bokuler /Russian transliteration/, a = 0.0310.

As indicated above, observations of 6 August give values of P (ϑ), which rather well satisfy expression (3), where k = 0.685 and $P_R(\vartheta)$ were computed by using formula (2). If instead of $P_R(\vartheta)$ we substitute values of $P_{R-C}(\vartheta)$ from formula (4), then expression (3) will also be quite well satisfied. This is confirmed by Table 1, in which values are given for P (ϑ), computed from expression (3) for three cases: 1) a = 0, $P(\vartheta) = 0.685\,P_R(\vartheta)$; 2) a = 0.031, $P(\vartheta) = 0.729\,P_{R-C}(\vartheta)$; 3) a = 0.0415, $P(\vartheta) = 0.745\,P_{R-C}(\vartheta)$.

Table 1

ϑ	a = 0	0.031 $P(\vartheta)$	0.0415
20 and 160°	0.043	0.044	0.044
40 and 140°	0.178	0.182	0.184
50 and 130°	0.284	0.289	0.291
60 and 120°	0.411	0.416	0.418
80 and 100°	0.645	0.646	0.646
90°	0.685	0.685	0.685

On the basis of observations of the brightness of the sky along the circle of altitude of the Sun with the polaroid in the three above-indicated positions, it was possible to determine the scattered light current $\mu(\vartheta)$ for different angles of scattering ϑ and divide it into two parts, to wit: into natural rays $\mu'(\vartheta)$ and polarized rays $\mu''(\vartheta)$. The ratio between these two scattered currents also changes with a change in atmospheric transparency. Figure 4 shows the dependence of $\mu'(\vartheta)$ and $\mu''(\vartheta)$ for $\vartheta = 90^\circ$ on the coefficient of transparency p. It can be seen that with an increase in atmospheric turbidity $\mu'(90^\circ)$ increases more rapidly than $\mu''(90^\circ)$. Approximately we have: when $p > 0.79$ $\mu'(90^\circ) < \mu''(90^\circ)$; when $p = 0.79$ $\mu'(90^\circ) = \mu''(90^\circ)$; when $p < 0.79$ $\mu'(90) > \mu''(90)$.

Such a ratio can probably be explained by the fact that aerosols possess less polarized light properties than do molecules. With a decrease in the transparency of the atmosphere, and therefore with an increase in the amount of aerosols, the scattered current in the polarized rays will increase more slowly than in the natural rays. As is shown in Figure 4, it is possible to assume as a good approximation that $\mu'(\vartheta)$ and $\mu''(\vartheta)$ change linearly with a change in the transparency of the atmosphere. ("Some Data on the Polarization of Atmospheric Light," by Ye. V. Pyaskovskaya-Fesenkova, Doklady Akademii Nauk SSSR, Vol. 131, No 2, 1960, pp. 297-299)

The Structure of Electron Inhomogeneities in the Sun's Outer Corona

1. Investigations of the outer corona of the Sun by the method of radioscopy have been accomplished until recently by the use of radiointerferometers oriented in an approximately east-west direction. Such observations have made it possible to measure the value of the effect of scattering in only one direction. On the basis of these observations we have derived data about the electron concentration of inhomogeneities of the outer corona, and have also discovered a dependence between the dimensions of the inhomogeneous outer corona and the phase of the 11-year cycle of solar activity.

It should be noted, however, that for an investigation of the form of a scattered source it is necessary to determine its dimensions in different directions, that is, utilize radiointerferometers with bases having different orientation. The desirability of such investigations was pointed out by V. V. Vitkevich and B. N. Panovkin in Astronom. Zh., 36, 544 (1959). Observations of such a type (not completely successful due to interference) were made in 1954 at the Crimean station of the Institute of Physics of the Academy of Sciences. In this case more reliable results were obtained with an interferometer oriented in a north-south direction.

However, from these observations relatively few data were derived concerning the form of the scattered source, although the results led to the conclusion that the effect of scattering was more noticeable in a direction perpendicular to the radius-vector connecting the source of radio emission and the Sun. Hence the conclusion was drawn that the inhomogeneities are elongated in an approximately radial direction from the Sun.

In 1958 we made the indicated observations on two wave lengths (λ = 3.5 m and λ = 5.8 m).

2. At the Crimean station of the Institute of Physics of the Academy of Sciences observations were made on the 5.8 m wave length when the source Taurus-A was covered by the outer corona. Two radio-interferometers were used; one of them, described by the senior author earlier (Astronom. Zh., 35, 1, 1958), was oriented in an east-west direction (observations were made by M. A. Ovsyankin), and the other interferometer was oriented at an angle to the first in such a way that the direction of the base to the north-south direction was 14.5°. The length of the base was 863 meters. The antennas were connected by a high-frequency cable. Head amplifiers were installed under each of the antennas for the compensation of damping caused by the cable. The receiving apparatus operated by the modulation method. The width of the receiver band was Δf = 0.5 mc, the sensitivity was $\Delta T \sim 2°K.$, the time constant, about 12 seconds. An electronic potentiometer was used as a recording instrument. The speed of movement of the diagram paper was 36 cm·hour^{-1}. The power feed of the receiving apparatus for anode and filament was stabilized. Checking of the correctness and stability of the coefficient of amplification of the apparatus was accomplished daily by means of reception of radio emission of a source in the constellation Virgo and also by means of noise generators.

Systematic observations were made during nearly all of June 1958. In the period of observations the Sun was in a state of calm and did not hinder reception of radio emission from the source in the constellation Taurus. The only interference was from static, which hampered observations, resulting in fewer data for the second phase of eclipse. The curve of intensity of radio emission for the source in the constellation Taurus, covered by the Sun's corona, is given in Figure 1 (for the first and second radiointerferometer). As can be seen from the sketch (see curve 1), a decrease in intensity was already noted on the second interferometer on 8 June; later the intensity increases and beginning on 24 June the intensity becomes stable. However, observations made this year on the east-west base (curve 2, Figure 1), as well as observations made in past years on the horizontal bases, show that a decrease in intensity of the source is usually observed beginning on 11 or 12 June (in 1957 -- from 10 June). Thus, observations from a slanting base gave a completely reliable result, to wit: the effect of scattering of radio waves is observed considerably earlier than on an east-west base. If we project the direction of the base on the celestial sphere (Figure 2), it is then easy to demonstrate that in the first phase of the eclipse we observe on the second base a scattering in a direction close to a perpendicular relative to the straight line connecting the source and the Sun. (In the second phase of the eclipse the angles of scattering also prove to be greater for the second base. These data, however, in view of the presence of static, "still need to be refined and checked in detail.) Hence it follows that the effect of scattering is more clearly expressed in a direction close to the perpendicular (Figure 2a), than in a direction close to the horizontal (Figure 2b), that is, inhomogeneities of the outer corona have approximately a radial structure.

3. At the Serpukhovo radiophysical station of the Institute of Physics of the Academy of Sciences the same apparatus was used for observations on a wave length of $\lambda = 3.5$ m (as in 1957). Observations were made in the morning and evening using the interference method with a base of 320 m (that is, 95λ). This method of observations is given in an article by Vitkevich and Panovkin, Astronom. Zh., 36, 544 (1959). On this occasion we succeeded in getting more reliable results on the 3.5 m wave length than in the previous year. Unfortunately heavy static did not permit us to conduct satisfactory evening observations.

The derived data made it possible to draw a curve of the change of relative depth of modulation according to morning observations (see Figure 3). Evening observations gave a total of several points whose position, however, differs from the curve of variation of morning observations.

From Figure 3 it follows that:

a) the beginning of noticeable changes in relative depth of modulation is already noted on 8 June;

b) there occurs some asymmetry of the curve relative to the maximum of covering (it is very clearly observed);

c) in the first phase of eclipse the morning observations give a relatively greater depth of modulation than do evening observations. This result is interesting to compare with the position of the projection of the base of the interferometer on the celestial sphere at the time of observations, as was done in Figure 4.

The measurements made on wave lengths 3.5 m and 5.8 m unquestionably confirm that the scattering is anisotropic. Electron inhomogeneities in which scattering occurs have an elongated form and are oriented predominantly in a radial direction in relation to the Sun.

At the present time the derived data are being processed in greater detail. ("Structure of Electron Inhomogeneities in the Outer Corona of the Sun," by V. V. Vitkevich, B. N. Panovkin, and A. G. Sukhovey, Izvestiya Vysshikh Uchebnykh Zavedeniy -- Radiofizika, Vol 2, No. 6, 1959, pp. 1005-1007)

Determination of the Density of the Neutral Component in the Ionosphere -- Full Translation of a Soviet Article

Our ideas about the basic physical characteristics of the upper atmosphere have recently undergone considerable changes. Data on the distribution of the density of the neutral component give evidence of the presence of a density that is approximately 10 times greater than was assumed only two years ago. For the most part these results are the product of data received from the artificial earth satellites.

However, the determination of the density of both the ionized and neutral components requires experimental checking by other independent methods. It is desirable that in such a method a single experiment will enable us to get the basic characteristics of the upper atmosphere, that is, its density and temperature. Such an experiment has been proposed by I. S. Shklovskiy. The idea on which the experiment is based is extraordinarily simple. At the required elevations sodium vapors are ejected from a high rocket either at dawn or dusk. (Such a method was used earlier in the United States for determination of wind velocity and other atmospheric parameters at altitudes on an order of 100 km. In these experiments no attempt was made to determine the density of the atmosphere.) This cloud, illuminated by the Sun, was lit up as a result of resonance fluorescence. It could therefore be observed from the Earth's surface. In our experiment the vapor ejection occurred at an altitude of 430 km above the Earth's surface. The height of the Earth's shadow at the time of the experiment was 300 km. Observations lasted for 15 minutes and during this time we made 50 photographs of the cloud. During this time the cloud assumed dimensions of several hundred kilometers. Since each sodium atom experiences a great number of collisions with atmospheric atoms, diffusion begins in the cloud a short interval of time after the ejection of the sodium vapors (it can be demonstrated that this time amounts to 100 seconds).

We should bear in mind, however, that the diffusion of sodium in the atmosphere occurs in a nonhomogeneous medium in the presence of the force of gravity. In this case the diffusion equation is written in the form:

$$\frac{\partial u}{\partial T} = \operatorname{div}(D \operatorname{grad} u) + \operatorname{div}(V_z u) - C, \qquad (1)$$

where $\underline{u}$ -- the concentration of atoms of sodium, $\underline{D}$ -- the coefficient of diffusion, V_z -- the velocity of drift of sodium atoms in the field of gravity, $\underline{C}$ -- the differences between the number of atoms of sodium ionized by the ultraviolet radiation of the Sun, and the number of newly appearing atoms. In our case $\underline{C}$ may be assumed equal to zero, since the lifetime of the sodium atoms in the field of the Sun's radiation is several hours.

We solved equation (1) with two different initial conditions: 1) diffusion begins from the moment t = 0, when the distribution of particles has the form:

$$u = Q\delta(z)\frac{\delta(r)}{r},$$

where Q -- the total number of sodium atoms in the cloud; 2) the diffusion begins from the moment $t = t_0$, when the sodium atoms evenly fill a sphere with the radius R_0.

We first simplify the equation, assuming therein that $V_z = 0$, D = const. Then the solution in the first case has an extremely simple form:

$$u = \frac{Q}{4\sqrt{\pi}\,(Dt)^{3/2}}\, e^{-R^2/4Dt} \quad . \tag{2}$$

By comparing expression (2) with the experimentally derived dependence of u on R, we can get the value of the coefficient of diffusion D. The latter, in its turn, is related to atmospheric density n:

$$D = \frac{3\pi}{32}\,\frac{1}{nQ_d}\sqrt{\frac{8kT}{\pi}\left(\frac{M_1 + M_2}{M_1 M_2}\right)}\,, \tag{3}$$

where Q_d -- the effective cross section of diffusion, T -- the temperature of atmospheric atoms, M_1, M_2 -- the mass of atoms of the atmosphere and sodium.

Substituting in (3) the numerical values for a height of 430 km and assuming that the atmosphere at this height consists of atomic oxygen (everything now points to this), we find for the concentration of atmospheric atoms, as a first approximation, the value $0.8 \cdot 10^8 \text{cm}^{-3}$.

Then we improve this result, rejecting the point initial conditions. In this case the solution for our centrally symmetrical problem will be

(here $\psi(z) = \frac{2}{\sqrt{\pi}}\int_0^z e^{-t^2}dt$ -- the integral of probability)

$$u(0,t) = u(0.0)\left[\psi\left(\frac{R_0}{\sqrt{2Dt}}\right) - \frac{R_0}{\sqrt{4\pi Dt}}\, e^{-R_0^2/4Dt}\right]. \tag{4}$$

By comparing the experimentally found concentration in the center of the cloud with expression (4), we find that the best agreement is achieved when $n = 1.8 \cdot 10^8 \text{cm}^{-3}$. A detailed description of the method for finding the concentration of sodium atoms is contained in an article by Shklovskiy and Kurt in Iskusstvennyye sputniki Zemli (Artificial Earth Satellites), 3, 66, 1959.

Now let's evaluate the influence of the force of gravity and the density gradient of the atmosphere. For the sake of simplicity we limit ourselves to a one-dimensional case with point initial conditions. Equation (1) will have the solution:

$$u(z,t) = \frac{Q}{2\sqrt{\pi D_0 t}} e^{-(z + Vzt)^2/4D_0 t} \qquad (5)$$

for a case of a homogeneous atmosphere in the presence of the force of gravity, that is, when $D = D_0$ = const. and V_z = const. $\neq 0$. In (5) $V_z = \lambda g/v_t$, λ -- the mean length of the free flight of a particle, g -- acceleration of the force of gravity, v_t -- thermal velocity. For a case of a nonhomogeneous atmosphere with a constant temperature and without taking the force of gravity into account, that is, when $D = D_0 e^{\alpha z}$, $V_z = 0$, the solution of (1) has the form:

$$u = \frac{\alpha Q}{D_0 \alpha^2 t} \exp - \left(\frac{\alpha z}{2} + \frac{1 + e^{-\alpha z}}{D_0 \alpha^2 t} \right) I_1 \left(\frac{2e^{\frac{-\alpha z}{2}}}{D_0 \alpha^2 t} \right), \qquad (6)$$

where α -- a value inverse to the height of a homogeneous atmosphere, D_0 -- the coefficient of diffusion for the height at which the sodium vapors are ejected, I_1 -- the Bessel function of the imaginary argument. In the first case we have the even downward movement of a cloud with the velocity V_z, in our experiment equal to $3 \cdot 10^3$ cm $\cdot$ sec^{-1}. The form of the cloud at this time remains the same as in the absence of the force of gravity.

In the second case the cloud is deformed, while the region of maximum concentration moves downward with ever decreasing velocity. The position of the point of maximum concentration is found from the equation:

$$I_1 \left(\frac{2e^{\frac{-\alpha z}{2}}}{D_0 \alpha^2 t} \right) e^{\frac{-\alpha z}{2}} = I_0 \left(\frac{2e^{\frac{-\alpha z}{2}}}{D_0 \alpha^2 t} \right) \qquad (7)$$

where I_1 and I_0 -- the Bessel functions of the imaginary argument.

Figure 1 shows the dependence of the value of cloud subsidence on time in dimensionless coordinates.

The action of the force of gravity and the influence of the density gradient of the atmosphere leads to a shifting of the effective center of the sodium cloud by less than 50 km in 1,000 seconds; this can be completely ignored, especially if observations last for about 500 seconds.

The above-described method is used for a limited range of heights. Its lower boundary is determined by the time of observation because the Sun at the time of observations is situated too close to the horizon. The upper boundary is determined by the fact that the cloud is scattered more rapidly than diffusion can begin. This method is applicable, evidently, to a range of heights from 250 to 600 km, that is, it embraces almost the entire region of the ionosphere. Figure 2 gives the data for determination of atmospheric density above 200 km.

Finally, we note that the sodium cloud method enables us to also determine the temperature of the atmosphere using the Doppler width of emission lines. Such observations will be made in the near future. ("Determining the Density of the Neutral Component of the Ionosphere," by V. G. Kurt, Izvestiya Vysshikh Uchebnykh Zavedeniy -- Radiofizika, Vol. 2, No. 6, 1959, pp. 1007-1009)

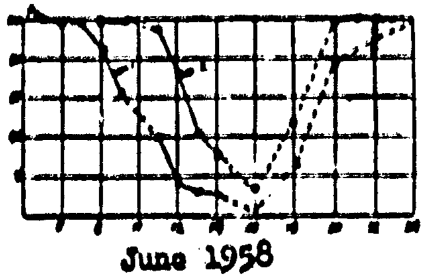

Figure 1. Measured intensity of radioemission of the source Taurus-A (λ = 5.8 M):

(1) base in east-west direction;

(2) base in north-south direction.

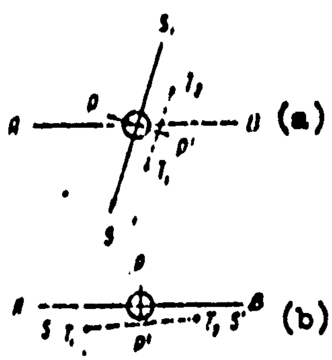

Figure 2. Projection of the radio-interferometer base on the celestial sphere (λ = 5.8 M):

(a) base oriented in north-sourth direction;

(b) base oriented in east-west direction (S = Sun, T_1 and T_2 = locations of source Taurus-A up to and after eclipse; AB = projection of the interferometer base; ss' = daily movement of the Sun; p,p' = Sun's axis.

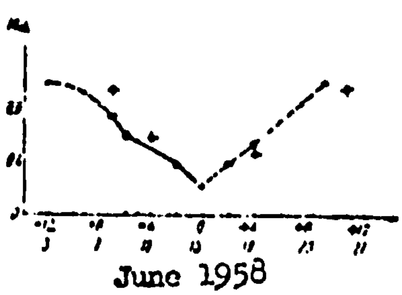

Figure 3. Measured intensity of radioemission of the source Taurus-A (λ = 3.5 M):

...morning observations, + + + evening observations.

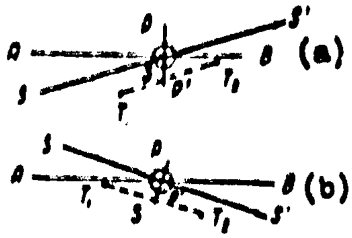

Figure 4. Projection of the radio-interferometer base on the celestial sphere ($\lambda \approx 3.5$ M), Symbols are same as in figure 2.

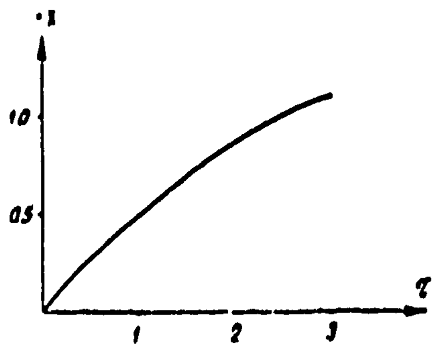

Figure 1. Displacement of the region of maximum concentration in dimensionless coordinates x az, δ $D_o a^2 t$.

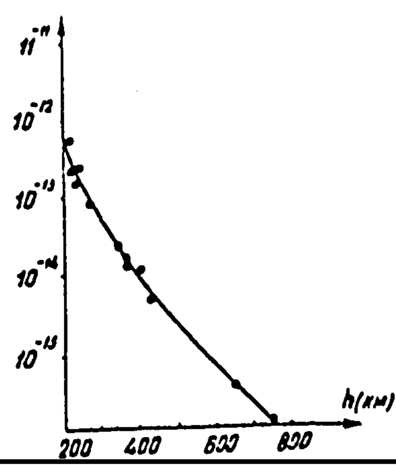

Figure 2. Distribution of the density of the neutral particles according to altitude h in the ionosphere.

Meteor Observed in the Rays of the Rising Sun

The following is a brief note in the March 1960 issue of Pravda:

On 13 August 1959 at 0540 hours, that is, approximately 20 minutes before sunrise, I observed the flight of a meteor in the rays of the rising Sun.

I determined the position of the constellation Cassiopeia while facing the Sun at a moment when all the stars of the heavens had grown dim in the rays of the rising Sun. A meteor appeared from the constellation Cassiopeia; it flew in the direction of the star Betelgeuse, that is, from west to east. The angle of inclination of the trajectory to the horizon was about 70°. The flight was observed for 3-4 seconds. It emitted an even and extremely bright silvery-white, rapidly twinkling light with a stellar magnitude of 1. ("A Meteor in the Sun's Rays," by S. I. Torshenko, Priroda, No. 3, March 1960, pp. 110-111)

Description of Noctilucent Clouds Observed in Vitebsk Oblast

The following is the full text of a brief article appearing in the most recently received issue of Priroda. The author is S. N. Sredinskiy of the Minsk Division of the All-Union Astrogeodetic Society:

On the night of 15-16 July 1959 very bright noctilucent clouds were observed at Zaslonovo (Lepel' rayon, Vitebsk oblast, Belorussian SSR). At 0130 hours Moscow Legal Time I entered my garden and noted an unusually bright glow in the northern part of the heavens. The brightness of this light was so great that objects cast shadows.

The clusters of noctilucent clouds did not come into contact with the horizon; the clouds on the horizon, by contrast, formed a lustreless band of a reddish-brown color. Above the clouds the sky was greenish, not the usual blue. Below this the color underwent a transition to a slightly golden hue.

The clouds moved in the direction of the zenith. At 0200 hours they occupied a stretch from χ of the Great Bear (on the west) to a perpendicular drawn to δ of Perseus (on the east). Above the cloud did not extend directly to the north, but somewhat to the east. The height of the clouds attained approximately half that of Capella (Auriga). In accordance with the adopted classification these clouds belonged to type II b (bands). In general the cloud accumulation had the form of a flat arc or semicircle.

At 0310 hours the glow began to burst into flames but the clouds began to grow pale; nevertheless they remained rather bright and rose still higher until the height of their upper margins attained the height of Capella. The space they occupied extended out to either side -- on the west to a perpendicular dropped from γ of the Great Bear, and on the east to a perpendicular from _ of Andromeda. At this time the clouds at the top took on a clearly expressed bluish-silvery hue, while at the bottom the color was golden. The cloud forms changed: in addition to the bands oriented upwards and to the sides there now appeared crests (IIIb) and curls (IVb).

At 0325 hours the clouds disappeared on the background of the nightglow. During the entire period of visibility of the noctilucent clouds the sky remained clear. Only at the eastern edge of the accumulation of noctilucent clouds were there some small individual clouds similar to high cumulus: on the background of noctilucent clouds they seemed almost black. As was the case on the day preceding the appearance of the noctilucent clouds, the weather was clear on the day following.

It is interesting to note that on the eve of the appearance of the noctilucent clouds a large group of spots passed across the central meridian of the Sun and there was radio interference on 15 July. This again suggests the possibility of a relationship between noctilucent clouds and phenomena on the Sun's surface, a relationship long established for auroras. ("Bright Noctilucent Clouds," by S. N. Sredinskiy, Priroda, No 3, March 1960, p 110)

New Insight into the Physics of Variable Stars

The following unsigned article is taken from the Soviet scientific journal Priroda:

It is not without reason that variable stars are called the lighthouses of the Universe: because of them we are able to calculate the immense distances to the extragalactic nebulae and comprehend the size and scale of the cosmos that is investigated by astronomical science. The study of variable stars has become exceptionally timely in our present day when the problems of astronautics have become a matter for science and technology, not a subject for fantasy.

A variable star can change in brightness two or three times in a period of several score hours. It can repeat this process with a periodicity and precision that in many cases exceeds the accuracy of the best clocks made by man. What is the cause of such stellar behaviour? This problem has been treated in a report by Professor D. A. Frank-Kamenetskiy delivered at a seminar session held in the Institute of Physical Problems of the Academy of Sciences of the USSR.

A variable star with a strictly recurring period was observed for the first time in December 1784, 175 years ago, by an eighteen year old deaf and dumb youth named John Goodricke. In the four years before his premature death (he died at age 22), he succeeded in discovering and studying the variable stars δ of the constellation Cepheus and η of the constellation Aquila, thereby laying the foundation of this new branch of astronomy. Later many other stars of this same type were discovered and were all called Cepheids after the name of the first such star that had been observed. Since then we have succeeded in answering many complex problems of astronomy and astrophysics, but the riddle of the Cepheids has still not been completely solved.

Let's briefly mention how the Cepheids are used for calculation of distances in space. It appears that the period of change of brightness of a star of the type δ Cepheus is associated with absolute stellar magnitude. The period of the Cepheids can be determined with a high degree of accuracy if observed for several years and the entire length of observation is then divided by the number of periods. By knowing the ratio between "period -- brightness," we can determine their absolute brightness; by comparing it with the observed luminosity, we can determine the distance to a star because the apparent luminosity of a star decreases inversely proportional to the square of its distance from the observer.

In addition to the Cepheids there are long-period variable stars and stars that experience flareups, but neither type possess exact periods; they make it impossible for us to reliably establish a relationship between period and brightness.

The history of efforts to give a theoretical explanation of the nature of the Cepheids is extremely interesting, but the only theory that may be regarded as satisfactory is one which was expounded at the end of the 19th century. This theory regards the Cepheids as pulsating gaseous spheres. During the adiabatic expansion of such a gaseous star the temperature should drop and the luminosity should therefore decrease; this is because brightness depends more on temperature than on area (adiabatic processes are those in which there is neither heat loss or gain). That the Cepheids actually pulsate has been confirmed by the Russian astronomer A. A. Belopol'skiy by study of the Doppler effect in the Cepheids. But it appears that the change in luminosity with time does not correspond to the adiabatic law. The maximum luminosity does not appear when the gaseous sphere of the star occupies the least volume, but at the time of the maximum velocity of expansion of the star, that is, it corresponds to the maximum displacement of spectral lines in the violet direction. The maximum red displacement corresponds to the minimum luminosity. As is well known, the violet displacement corresponds to the approach of a luminous body, and red -- to its recession, with the value for displacement proportional to velocity. This is called the Doppler effect.

The absence of smearing in the displaced spectral lines indicates a regularity in movement and shows that it takes place rather strictly along the radius, that is, that the star, in expanding and contracting, maintains the form of a sphere. In new and ultranew stars, whose luminosity increases as a result of an explosion, a violet displacement is also observed, but the spectral lines are smeared because the movement of gaseous masses in these cases occurs in an irregular fashion. In the presently prevailing theory the process of contraction and expansion of a stellar sphere is considered in the first approximation to be adiabatic; the reason for this is that the time of equalization of temperature throughout the entire star may be regarded as much greater than the time of one variation, while the radiation is small in comparison with the full energy. Then, by using ordinary Newtonian equations, it is possible to use the values for the mass and radius of a star to compute the frequency of pulsation, that is, the period of the Cepheid. Thus, the mechanism of fluctuations in which forces of gravitation and gas pressure participate, and their frequency, becomes understandable. But for the time being it is still unclear under the influence of what forces the pulsations can develop because this is impossible in a strictly adiabatic process.

Therefore to explain these variations it is necessary to look into nonadiabatic processes. The variations may be due to thermonuclear processes in the interior of the star, but also (however unlikely it may seem at first glance), to heat emission on the periphery under certain conditions.

If the relative value of change in density was everywhere identical within a star, then all stars should pulsate due to the dependence of velocity of nuclear reactions on temperature. But in actuality only one star in a million is a Cepheid. The reason for this is that the density of a star increases sharply toward the center and with such a change in density the amplitude of the standing waves should likewise decrease sharply. In the central zone, where nuclear reactions occur, variations are practically absent and their excitement should not be associated with the sources of stellar energy. We arrive at this conclusion if we regard the pulsations of the Cepheids as standing sound waves with antinodes on the free surface of the star.

The author and several other researchers feel that these difficulties can be solved if the pulsation of the Cepheids is explained not by standing waves, but by travelling waves instead, and if we assume that at each cycle there occurs the expulsion of some quantity of stellar matter. Such an assumption, not excluding the excitation of pulsations by thermonuclear reactions in the interior of stars, sharply limits the class of stars capable of possessing the properties of Cepheids, as coincides with observed facts. ("The Physics of Variable Stars," Priroda, No 3, March 1960, pp. 106-107)

Soviet Astronomer Comments on Current Solar Activity

V. Lutskiy, a lecturer at the Moscow Planetarium, is the author of the following feature article appearing in the leading Moscow daily Izvestiya:

For the last few days our great luminary the Sun has been restless. The astronomical observatories of the Soviet Union and other countries have recorded a sharp increase in the brightness of several areas on the Sun, so-called chromospheric flares.

Recently, on 25 March, a very large group of spots appeared from behind the edge of the Sun's disk. These spots were the result of the turbulent activity of extraordinarily hot solar gases. The nature of such spots is still not entirely understood. However, by means of spectral analysis, movie films, and other methods of scientific research we have successfully established that such a spot is a sort of "vortical tube" in which there is a continual movement of matter at a rate of several kilometers a second. It is extremely interesting to note that within these "tubes" there is both an "inflow" of gases into the interior of the Sun and an "outflow" of gases from the center to the surface.

One of the interesting properties of sun spots is that they possess a strong magnetic field. The largest of these spots are a source of intense radio emission. On 29 March at 0940 hours Moscow time an intense chromospheric flare -- a powerful outburst -- was observed on the Sun in the vicinity of this group of spots. An intense magnetic and ionospheric storm began in the Earth's atmosphere on 31 March at 1200 hours Moscow time. Late on the evening of 31 March an intense auroral display was observed in the middle latitudes. Radio communications were disrupted for several hours on 1 April in the short wave frequencies in the high, middle and low latitudes. For example, communication was disrupted between Europe and America and also between several cities in Europe.

Solar activity has become less intense during the last few days. However it is still possible to observe brief disruptions of radio communications as a result of these powerful phenomena which are occurring on the Sun. ("Powerful Outburst on the Sun," by V. Lutskiy, Izvestiya, 7 April 1960, p 4)

"On the Theory of the Formation of Ionospheric Inhomogeneities in the F-layer"

The study of ionospheric inhomogeneities presently occupies a leading place in radio research of the ionosphere. Together with numerous experimental investigations a series of mechanisms has been proposed to explain the formation of irregularities in the electron concentration of the ionosphere. A listing and a critical discussion of these mechanisms can be found in articles by Booker in the Journal of Geophysical Research, 61, 673, 1956, by Dagg in the Journal of Atmospheric and Terrestrial Physics, 10, 194, 1957, and by Gershman and Ginzburg in this journal, 2, 8, 1959. An analysis of these works shows that the theoretical interpretation of the development of inhomogeneities in the F-layer is extremely difficult.

In this article we only discuss one of the mechanisms involved in the formation of inhomogeneities. This mechanism was proposed by Martyn (Conference on Physics of the Ionosphere, Cambridge, 163, 1955); later its possibilities were analyzed in greater detail by Dagg (Journal of Atmospheric and Terrestrial Physics, 11, 139, 1957). According to the Martyn-Dagg mechanism, the development of inhomogeneities in the F-layer is associated with the transfer into this layer of the dynamo-region of the electrical fields (the dynamo-region is situated at a height of 130 km). The regular components of these fields lead to a drift of charged particles in the F-layer, with which is also identified the experimentally observed ionospheric "wind." The variable component of the transferred electrical field should lead to the manifestation of ionospheric inhomogeneities.

The mentioned works by Martyn and Dagg essentially contain only the formulation of the proposed hypothesis and completely lack quantitative evaluations. Computations, as is clear from what follows, enable us to more completely investigate the possibility of the mechanism in question. Below we give the computation of the effect of infiltration of the electrical field from the E-layer into the F-layer and discuss the derived formulas. We show that the Martyn-Dagg mechanism in itself is inadequate for an explanation of experimental data.

1. During an examination of the infiltration of the field from the E-layer into the F-layer we come to the problem of the skin effect in plasma. At this time the calculation of the anisotropy of conductivity associated with the Earth's magnetic field H_o and change in conductivity with height prove to be quite important.

It is possible to begin directly from the microscopic equation for the electrical field E:

$$\nabla^2 E - \frac{1}{c^2}\frac{\partial^2 E}{\partial t^2} = \frac{4\pi}{c^2}\,\partial j/\partial t, \tag{1}$$

where j -- the complete microscopic current. This equation was written for a case when div $E = 4\pi e(N_i - N_e) \simeq 0$ (-e -- the charge of the electron, N_e and N_i -- the concentration of electrons and ions). The latter condition is fulfilled for quasineutral plasma, when $N_e \simeq N_i$. It should be realized for not very rapid quasistationary movements in the ionosphere. It is precisely with this type of movements that we will deal.

The current j is associated with the electrical field E by the generalized Ohm law. For quasistatic processes it can be written in the form:

$$j = \sigma_o (hE')h + \sigma_1 [[hE']h] + \sigma_2 [hE'] , \tag{2}$$

where h -- the only vector in the direction of the field H_o. In addition, in virtue of the presence in the general case of movement of the medium in (2) we do not have the field E, but the vector E', determined by the ratio:

$$E' = E + E_{\blacksquare} = E + \frac{1}{c}[vH_o] , \tag{3}$$

where the field $E_{\blacksquare} = \frac{1}{c}[vH_o]$ is called the dynamo-field (v -- velocity of the medium). In (2) σ_o, σ_1, and σ_2 -- are respectively the longitudinal and transverse conductivity and Hall conductivity:

$$\sigma_o \simeq \frac{e^2N}{m\nu_e}; \quad \sigma_1 = e^2N\left[\frac{\nu_e}{m(\omega_H^2+\nu_e^2)} + \frac{\nu_i}{M(\Omega_H^2+\nu_i^2)}\right];$$

$$\sigma_2 = e^2N\left[\frac{\omega_H}{m(\omega_H^2+\nu_e^2)} - \frac{\Omega_H}{M(\Omega_H^2+\nu_i^2)}\right]. \tag{4}$$

Here ν_e -- the effective number of collisions of electrons with other particles, ν_i -- the number of collisions for ions, ω_H and Ω_H -- the gyrofrequency for electrons and ions, m and M -- masses of electrons and ions, $N \equiv N_e \simeq N_i$.

We select, bearing in mind a fixed point on the globe, the following system of Descartes coordinates. The axis x we direct at the geomagnetic equator, the axis y -- eastword, the axis z, vertically upward. In these coordinates the Earth's magnetic field is $H_0 = H_0 h = - H_0 \cos\chi i - H_0 \sin\chi k$, where χ -- magnetic declination. Writing equation (1) in coordinate form and taking equation (2) into account, we get:

$$\nabla^2 E_x - \frac{1}{c^2}\frac{\partial^2 E_x}{\partial t^2} = \frac{4\pi}{c^2}\frac{\partial}{\partial t}\Big\{(\sigma_0 \cos^2\chi + \sigma_1 \sin^2\chi)E'_x + \sigma_2 \sin\chi E'_y + (\sigma_0 - \sigma_1)\sin\chi\cos\chi E'_z\Big\} \; ; \qquad (5)$$

$$\nabla^2 E_y - \frac{1}{c^2}\frac{\partial^2 E_y}{\partial t^2} = \frac{4\pi}{c^2}\frac{\partial}{\partial t}\Big\{\sigma_1 E'_y - \sigma_2 \sin\chi E'_x + \sigma_2 \cos\chi E'_z\Big\} \; ; \qquad (6)$$

$$\nabla^2 E_z - \frac{1}{c^2}\frac{\partial^2 E_z}{\partial t^2} = \frac{4\pi}{c^2}\frac{\partial}{\partial t}\Big\{(\sigma_0 - \sigma_1)\cos\chi\sin\chi E'_x - \sigma_2\cos\chi E'_y + (\sigma_0 \sin^2\chi + \sigma_1 \cos^2\chi)E'_z\Big\} . \qquad (7)$$

We take into account conditions which occur in the ionosphere at heights exceeding 130 km. Under the condition $\nu_i \gg \Omega_H$ the conductivity is $\sigma_1 \gg \sigma_2$, so that one may approximately consider that $\sigma_2 \simeq 0$. The change of the conductivities σ_0 and σ_1 with height is determined (through the number of collisions), above all by a change in the concentration of neutral particles and not by a change with height of the electron concentration N. At heights greater than 130 km it may be assumed approximately that

$$\sigma_0 = \sigma_{00} e^{z/z_0} \; ; \qquad \sigma_1 = \sigma_{10} e^{-z/z_0} \; , \qquad (8)$$

where z_0 -- the scale of a homogeneous atmosphere.

After disregarding the terms with σ_2 and replacing the field E' with the field E*, we get a system of equations analogous to (5)-(7). (* In replacing the field E' by E we ignore the dynamo-field E_D. It is believed that the dynamo-field is large only in the E-layer, in the region of generation of the migrant fields.) However, even after these terms have been disregarded the solution of the interrelated equations for the component of the field E_x and E_z is extremely unwieldy (the equation for the component E_y when $\sigma_2 = 0$ is split off). Therefore we limit ourselves to two individual cases, to wit, we examine infiltration at high latitudes ($\chi \simeq 90^\circ$, $\cos\chi \ll 1$) and in equatorial regions ($\chi \simeq 0$, $\sin\chi \ll 1$). In these cases we have, respectively:

$$\nabla^2 E_{x,y} - \frac{1}{c^2}\frac{\partial^2 E_{x,y}}{\partial t^2} = \frac{4\pi\sigma_1}{c^2}\frac{\partial E_{x,y}}{\partial t}; \quad \nabla^2 E_z - \frac{1}{c^2}\frac{\partial^2 E_z}{\partial t^2} = \frac{4\pi\sigma_0}{c^2}\frac{\partial E_z}{\partial t}; \tag{9}$$

$$\nabla^2 E_x - \frac{1}{c^2}\frac{\partial^2 E_x}{\partial t^2} = \frac{4\pi\sigma_0}{c^2}\frac{\partial E_x}{\partial t}; \quad \nabla^2 E_{y,z} - \frac{1}{c^2}\frac{\partial^2 E_{y,z}}{\partial t^2} = \frac{4\pi\sigma_1}{c^2}\frac{\partial E_{y,z}}{\partial t}. \tag{10}$$

From (9)-(10) it follows that in these particular cases (for the component of the field E_y in a general case) it is necessary to solve two different types of equations:

$$\nabla^2 E_{\parallel} = \frac{4\pi\sigma_{00}}{c^2} e^{z/z_0} \frac{\partial E_{\parallel}}{\partial t} + \frac{1}{c^2}\frac{\partial^2 E_{\parallel}}{\partial t^2}; \tag{11}$$

$$\nabla^2 E_{\perp} = \frac{4\pi\sigma_{\perp 0}}{c^2} e^{-z/z_0} \frac{\partial E_{\perp}}{\partial t} + \frac{1}{c^2}\frac{\partial^2 E_{\perp}}{\partial t^2}. \tag{12}$$

We will seek a solution in the form

$$E \sim E(z)e^{i(\omega t - kx)}, \tag{13}$$

where k in the general case can also be complex. It is evident that by assuming independence of the conductivities from the horizontal components we would come to the same results for perturbations associated with changes in other directions. Therefore the problem of the field in the form of (13) does not limit the community of examination. By substituting (13) in (11) - (12), we get

$$\frac{d^2E_{\parallel}}{dz^2} + \left(\frac{\omega^2}{c^2} - k^2 - i\,\frac{4\pi\omega\sigma_{00}}{c^2}\,e^{z/z_0}\right) E_{\parallel} = 0\,; \qquad (14)$$

$$\frac{d^2E_{\perp}}{dz^2} + \left(\frac{\omega^2}{c^2} - k^2 - i\,\frac{4\pi\omega\sigma_{\perp 0}}{c^2}\,e^{-z/z_0}\right) E_{\perp} = 0. \qquad (15)$$

The solution of these equations can be found by using the substitution $x = \exp(z/z_0)$ for (14) and $x = \exp(-z/z_0)$ for (15). As a sum we get:

$$E_{\parallel}(z) = A_{\parallel} H_{\nu}^{(1)}\left(\frac{2z_0}{\lambda_{00}}\,e^{i3\pi/4 + z/2z_0}\right) + B_{\parallel} H_{\nu}^{(2)}\left(\frac{2z_0}{\lambda_{00}}\,e^{i3\pi/4 + z/2z_0}\right); \quad (16)$$

$$E_{\perp}(z) = A_{\perp} H_{\nu}^{(1)}\left(\frac{2z_0}{\lambda_{\perp 0}}\,e^{i3\pi/4 - z/2z_0}\right) + B_{\perp} H_{\nu}^{(2)}\left(\frac{2z_0}{\lambda_{\perp 0}}\,e^{i3\pi/4 - z/2z_0}\right), \quad (17)$$

where $H^{(1,2)}$ -- Hankel functions of the first and second type of the -th order.

$$\nu = 2z_0\sqrt{k^2 - k_0^2}\,; \qquad k_0 = \omega/c\,;$$

$$\lambda_{00} = c/\sqrt{4\pi\omega\sigma_{00}}\,; \qquad \lambda_{\perp 0} = c/\sqrt{4\pi\omega\sigma_{\perp 0}}\,.$$

The values of λ_{00} and $\lambda_{\perp 0}$ respectively determine the thickness of the skin layer during the penetration of the electrical field, parallel to the magnetic field H_0 or perpendicular to it.

For determination of the integration constants in (16) and (17) it is above all necessary to consider that in an absorbing medium when the coordinates tend $z \to \infty$ the fields should disappear. Hence we find that $B_{\parallel} = 0$, $A_{\perp} = B_{\perp}$, and, consequently, the solutions interesting us (16)-(17) can be written in the form:

$$E_{\parallel}(z) = A_{\parallel} H_{\nu}^{(1)}\left[\frac{2z_0}{\lambda_{00}}\,e^{i3\pi/4 + z/2z_0}\right];$$

$$E_{\perp}(z) = 2A_{\perp} J_{\nu}\left[\frac{2z_0}{\lambda_{\perp 0}}\,e^{i3\pi/4 - z/2z_0}\right].$$

Moreover, we assume that the generation of the field arises in the E-layer. That generation is not accompanied by any disruptions or very rapid changes in the properties of the medium. Then $A_{\parallel}$ and $A_{\perp}$ are determined on the condition that $E_{\perp}(0) = E_{\perp o}$ and $E_{\parallel}(0) = E_{\parallel o}$ when $z = 0$. As a result we have:

$$E_{\parallel}(z) = E_{\parallel o} H_{\nu}^{(1)}\left(\frac{2z_o}{\lambda_{oo}} e^{i3\pi/4 + z/2z_o}\right) \Big/ H_{\nu}^{(1)}\left(\frac{2z_o}{\lambda_{oo}} e^{i3\pi/4}\right); \quad (18)$$

$$E_{\perp}(z) = E_{\perp o} J_{\nu}\left(\frac{2z_o}{\lambda_{\perp o}} e^{i3\pi/4 - z/2z_o}\right) \Big/ J_{\nu}\left(\frac{2z_o}{\lambda_{\perp o}} e^{i3\pi/4}\right). \quad (19)$$

2. We use the ratios (18) and (19) for determination of the effectiveness of infiltration of the components $E_{\parallel}$ and $E_{\perp}$ of the electrical field, directed along the constant magnetic field H_o or perpendicular to it.

From the sense of the examined solutions it follows that λ_{oo} and $\lambda_{\perp o}$ are determined by the values of the conductivities σ_{oo} and $\sigma_{\perp o}$ in the field of development of the field (in the dynamo-region). In accordance with data cited in Martyn's article (Philosophical Transactions, A246, 913, 1953), at a height of 130 km $\lambda_{\perp o}^2 = 2\cdot 10^{14}\omega^{-1}$, and $\lambda_{oo}^2 = 10^{13}\omega^{-1}$. For the height of a homogeneous atmosphere z_o we use $z_o = 15$ km. We will be interested in processes whose period of change lies in the range of tens of seconds to several hours, that is, processes with a cyclic frequency of $\omega \sim 1 \div 10^{-4}$ sec^{-1}.

It is easy to establish that the argument of the Bessel function, both in the numerator and in the denominator of the ratio (19) is small in the modulus in virtue of the condition $\lambda_{\perp o} \gg z_o$, and also $\exp(-z/2z_o) \ll 1$. The latter condition is assumed because we are interested in the penetration of the fields for a considerable distance (into the maximum field of the F-layer). Then, using asymptotic approximations of cylindrical functions, from (19) we get:

$$E_{\perp}(z) \simeq E_{\perp o} e^{-\nu z/2z_o} = E_{\perp o} e^{-\sqrt{k^2 - k_o^2}\, z} \simeq E_{\perp o} e^{-kz}. \quad (20)$$

The latter equation is valid, since the value k_o is, at the indicated frequencies of ω, extremely small in comparison with k. We recall that the inverse length determines the character of the inhomogeneous structure of the initial distribution of electrical fields in the horizontal direction. Effective penetration is possible only at a distance of $\Delta z \sim 1/k$. At the same time $k \sim 1/l$, where l is the horizontal dimension of the inhomogeneity. Thus, the penetration of the small-scale perturbations with dimensions on the order of $l \sim 1 \div 10$ km proves to be impossible. At the same time the penetration of large-scale perturbations ($l \sim 100$ km) from the E-layer into the F-layer does prove to be possible. These fields can lead to the development of drifts of a more or less regular character in the F-layer.

Let's turn to the determination of the effectiveness of penetration of the component $E_{\parallel}$. Here we assume that $z \gg z_0$, and also consider that $\lambda_{00} > z_0$. By using the asymptotic concept for the Hankel function, from (18) we have:

$$E_{\parallel}(z) \simeq E_{\parallel 0} \exp \left[- z/4z_0 - (1 + i) z_0 \sqrt{2}\ \lambda_{00}^{-1} \exp(z/2z_0) \right] . \quad (21)$$

From this ratio it follows that the penetration of the field from the E-layer into the F-layer when $z \gg z_0$ proves to be practically impossible. In this connection we note that the decrease of the field during infiltration, be it a decrease of several times, leads to substantial difficulties during experimental comparison. The fact is that with a decrease in the field there could also be expected a decrease in the velocity of drift in the F-layer. In experiments we observe the reverse phenomenon instead: the velocity of movement in the F-layer is greater than the velocity of movement in the E-layer.

Thus, we come to the conclusion that only large-scale inhomogeneities of the electrical field are subject to migration. Processes of relatively low frequency are large-scale. The periods of change of value associated with these processes in any case are not less than several minutes. In addition the only components of the field E that migrate are those oriented perpendicular to the field H_0. Returning to the problem of the nature of the development of inhomogeneities in the F-layer, we arrive at the necessity of explaining the small-scale part of these inhomogeneities ($l \sim 2 + 5$ km) at the expense of processes directly in the F-layer itself. One of these possible processes might be convectional instability in the region of the F-layer. Recently one of the authors (V. P. Dokuchayev) has shown that the development of the negative temperature gradients necessary for convection may be associated with the action of a current of neutral particles arriving on the Earth from interplanetary space. However, estimates of the intensity of the required currents have led to values that are large in comparison with those accepted at the present time. ("On the Theory of the Formation of Ionospheric Inhomogeneities in the F-layer," by B. N. Gershman and V. P. Dokuchayev, Izvestiya Vysshikh Uchebnykh Zavedeniy -- Radiofizika, Vol 2, No 6, 1959)

III. METEOROLOGY

IGY Data Used for Prognosis of Mean Monthly Temperature Anomalies in the Northern Hemisphere

The following is the full text of a report by Ye. N. Blinova, Corresponding Member of the Academy of Sciences of the USSR:

In 1950 the author developed a method for long-range prognosis of temperature anomalies on the basis of the solution of a system of equations in hydrodynamics and thermodynamics. This method was tested under operational conditions right up to the end of 1957 (see, for example, S. A. Mashkovich, et al, _Tr. Tsentral'n. Inst. Prognosov_, issue 60, 1957). During this testing the initial data entering into the prognosis pertained to a limited territory; the method of representation of the initial fields of meteorological elements was not precise and prognoses were compiled and evaluated for only a part of the territory of the Northern Hemisphere. The IGY Program enabled us to elaborate the problem. For the first time it has proven possible, under operational conditions, to use rather complete aerological observations (from the point of view of a planetary scale). Thus, for example, a hydrodynamic prognosis of temperature anomalies for the entire Northern Hemisphere has become possible. This article sets forth the theory and some of the results of its use in the light of the utilization of IGY data.

1. It is assumed that the motion of the atmosphere is close to purely zonal rotation. The latter is characterized by an index of circulation α (the angular velocity of movement of the air in relation to the Earth) and a change in temperature between the pole and the equator (see Ye. N. Blinova, _Doklady Akademii Nauk SSSR_, 39, No 7, 1943), and Ye. N. Blinova, _Tellus_, 9, No 4, 1957). Computations have been made for one hemisphere of the Earth; in this case we assume the nonpenetration of air masses across the equator (the "washing out" of fields of meteorological elements at the equator). Air temperature T is represented in the form $T = \overline{T} + T' + T''$. Here $\overline{T}$ -- zonal temperature (derived by averaging along a circle of latitude); T' -- the mean climatic nonzonal part (quasi-stationary for the period of prognosis); T'' -- the nonzonal nonstationary part -- a temperature "anomaly." Our problem is to find T''. To do this we make use of the equation for heat influx.

We assume the Earth to be a sphere with the radius a_0, we describe atmospheric movements in a system of spherical coordinates θ (the complement of latitude), λ (longitude of the point) and z (height above sea level). The components of wind velocity along the axes θ and λ are designated respectively by v_θ and v_λ. The equation for heat influx is put into linear form in relation to purely zonal circulation. This means that the convectional terms of this equation

$$\frac{v_\lambda}{a_0 \sin\theta}\frac{\partial T}{\partial \lambda} + \frac{v_\theta}{a_0}\frac{\partial T}{\partial \theta} \qquad (1)$$

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we represent in the form

$$\frac{\bar{v}_\lambda}{a_0 \sin\theta}\frac{\partial T''}{\partial\lambda} + \frac{v''_\theta}{a_0}\frac{\partial \bar{T}}{\partial\theta} \quad , \qquad (2)$$

where $\bar{v}_\lambda$ -- the velocity v_λ averaged along a circle of latitude; v''_θ -- the nonstationary nonzonal part of the meridional velocity. We assume further

$$\bar{v}_\lambda = \alpha a_0 \sin\theta, \quad \bar{T} = T_0 + M \sin^2\theta \qquad (3)$$

(α and M -- constants). Then the equation for heat influx can be written approximately in the form

$$\frac{\partial\tau}{\partial t} + \alpha\frac{\partial\tau}{\partial\lambda} + 2M\frac{\sin\theta}{a_0}v''_\theta = \frac{k''}{a_0^2}\Delta\tau + \frac{\partial}{\partial z}\left(k'\frac{\partial\tau}{\partial z}\right). \qquad (4)$$

Here $\tau = \dfrac{T''}{\sin\theta}$; t -- time; $\Delta = \dfrac{1}{\sin\theta}\dfrac{\partial}{\partial\theta}\left(\sin\theta\dfrac{\partial}{\partial\theta}\right) + \dfrac{1}{\sin^2\theta}\dfrac{\partial^2}{\partial\lambda^2}$;

k' and k'' -- coefficients of turbulent temperature conductivity respectively along the vertical and horizontal.

The equation (4) takes into account the penetration of heat and cold along the meridians, advection by the main east-west currents, the smoothing out of temperature anomalies by means of horizontal movement and modification vertically.

We use for v''_θ in (4) the values of meridional velocity at the mean level of the atmosphere where we can introduce a flow function so that

$$v_\theta = -\frac{1}{a_0 \sin\theta}\frac{\partial\psi}{\partial\lambda}, \quad v_\lambda = \frac{1}{a_0}\frac{\partial\psi}{\partial\theta} \quad .$$

In this case

$$v''_\theta = -\frac{1}{a_0 \sin\theta}\frac{\partial\psi''}{\partial\lambda}$$

(ψ'' -- the nonstationary nonzonal part of ψ).

The function ψ satisfies the equation for movement of the vortex

$$\frac{\partial\Delta\psi}{\partial t} + \frac{1}{a_0^2 \sin\theta}\left(\frac{\partial\psi}{\partial\theta}\frac{\partial\Delta\psi}{\partial\lambda} - \frac{\partial\psi}{\partial\lambda}\frac{\partial\Delta\psi}{\partial\theta}\right) + 2\omega\frac{\partial\psi}{\partial\lambda} = 0.$$

Hence, after putting it in linear form in relation to flow (3), we get for ψ''

$$\frac{\partial\Delta\psi''}{\partial t} + \alpha\frac{\partial\Delta\psi''}{\partial\lambda} + 2(\alpha + \omega)\frac{\partial\psi''}{\partial\lambda} = 0. \qquad (5)$$

This equation is solved independently from (4). The solution for ψ'' in the case of the constant α can be represented in the form of a series

$$\psi'' = \sum_{n=1}^{\infty}\sum_{m=1}^{n}\left[D_n^m \cos(m\lambda + \sigma_n^m t) + D'^m_n \sin(m\lambda + \sigma_n^m t)\right] P_n^m(\cos\theta), \qquad (6)$$

where

$$\sigma_n^m = \frac{2(\alpha + \omega)m}{n(n+1)} - \alpha m \qquad (n - m \text{ odd}). \qquad (7)$$

From formula (6) it follows that D_n^m and D'^m_n are coefficients of expansion for the spherical functions of the initial field ψ''. To determine D_n^m and D'^m_n we can use an equation connecting the values for height H of the isobaric surface at 600 mb and the flow function:

$$2\left[\omega\cos\theta + \frac{1}{a_0}\frac{\partial v_\lambda}{\partial\theta}\right]\Delta\psi - 2\omega\sin\theta\frac{\partial\psi}{\partial\theta} - 2\left(\frac{\partial v_\theta}{\partial\theta}\right)^2 - 2\left(\frac{\partial v_\lambda}{\partial\theta}\right)^2 - v_\lambda^2 - v_\theta^2 = g\Delta H. \qquad (8)$$

By putting equation (8) in linear form we get:

$$\cos\theta\Delta\psi'' - \sin\theta\frac{\partial\psi''}{\partial\theta} = \frac{g}{2(\alpha + \omega)}\Delta H'', \qquad (9)$$

where $H''(\theta, \lambda, t)$ -- the nonstationary part of H.

The equation (9) is correct for any moment of time. If we represent $(H'')_{t=0}$ in the form of a series

$$H''(\theta, \lambda, 0) = \sum_{n=1}^{\infty}\sum_{m=1}^{n}(A_n^m \cos m\lambda + A'^m_n \sin m\lambda) P_n^m(\cos\theta) \qquad (10)$$

and assume from (6) $(\psi'')_{t=0}$, then from (9) we get

$$D_{n+1}^{m}\frac{(n+2)\,(n+m+1)}{(n+1)\,(2n+3)}+D_{n-1}^{m}\frac{(n-m)\,(n-1)}{(2n-1)\cdot n}=\frac{g}{2(\alpha+\omega)}A_{n}^{m}. \tag{11}$$

The recursion formula (11) permits us to successively determine D_n^m through A_n^m (in a similar way D'^m_n is determined through A'^m_n).

Thus, v''_θ, forming part of (4), may be computed by the known function from θ, λ, and t, provided the initial field H is known for the mean level of the atmosphere.

2. The problem amounts to a determination of τ from (4) when v''_θ is known. As boundary conditions for z we use the condition of thermal balance at the Earth

$$-\lambda'\frac{\partial\tau}{\partial z}+\lambda_*\frac{\partial\tau^*}{\partial z}=S''-\mu\tau$$

$$\text{when } z=0, \tag{12}$$

where λ'' -- the coefficient of turbulent heat conductivity of the air vertically, and $\lambda*$ and $\cos\theta\tau*$ are respectively the coefficient of turbulent heat conductivity and the temperature anomaly of the underlying surface; S'' -- a value associated with deviation from the norm of the heat influx from the Sun; μ -- a parameter characterizing radiation from the underlying surface. The heat involved in evaporation is considered indirectly (through a change in the coefficient λ').

To complete the problem we write another equation:

$$\frac{\partial\tau*}{\partial t}=k*\frac{\partial^2\tau*}{\partial z^2} \tag{13}$$

(k* -- the coefficient of temperature conductivity of the underlying surface). The solution of equation (13 is sought under these conditions

$$\tau*=\tau \text{ when } z=0,\quad \tau* \text{ is limited when } z\to-\infty \tag{14}$$

At first glance the value of the initial field τ can prove to be substantial for prognosis. But due to turbulent dissipation the influence of initial τ within a few days ceases to be noticeable (dies out). On the other hand, all new penetrations of heat or cold along a meridian (described by the term containing v''_θ in (4)) will occur in the course of the entire prognosis period. We will seek a "settled regime," considering that the initial values of τ have already died out. ("Settled regime" was introduced by the author when solving this problem in 1950; the solution was immediately adopted for use under operational conditions. Later an attempt was made by Ye. M. Dobryshman to include the influence of initial temperatures in the examination. However, the consideration of this influence did not improve the quality of the prognosis.)

The appropriate solution has the form (we assume λ', λ^*, k', k^*, k'', μ to be constant)

$$\tau = \sum_{n=1}^{\infty} \sum_{m=1}^{n} \left[\tau_{1n}^{m}(z)\cos(m\lambda + \sigma_n^m t) + \tau_{2n}^{m}(z)\sin(m\lambda + \sigma_n^m t)\right] P_n^m(\cos\theta), \tag{15}$$

$$\tau^* = \sum_{n=1}^{\infty} \sum_{m=1}^{n} \left[\tau_{1n}^{m}(z)\cos(m\lambda + \sigma_n^m t) + \tau_{2n}^{*m}(z)\sin(m\lambda + \sigma_n^m t)\right] P_n^m(\cos\theta),$$

and in accordance with (4), (6), (12), (13) and (14)

$$\tau_{1n}^{m} + i\tau_{2n}^{m} = \frac{2M}{a_o^2}\left\{1 - \frac{a_n^m}{a_n^m + \sqrt{\tilde{\sigma}_n^m}} \exp\left[-(1-i)\sqrt{\frac{\tilde{\sigma}_n^m}{2k'}}\, z\right]\right\}\frac{m}{\tilde{\sigma}_n^m}(D_n^m + iD_n'^m), \tag{16}$$

$$\tau_{1n}^{*m} + i\tau_{2n}^{*m} = \frac{2Mm}{a_o^2\sqrt{\tilde{\sigma}_n^m}}\,\frac{D_n^m + iD_n'^m}{a_n^m + \sqrt{\tilde{\sigma}_n^m}} \exp\left[(1-i)\sqrt{\frac{\sigma_n^m}{2k^*}}\, z\right], \tag{17}$$

where

$$\tilde{\sigma}_n^m = \sigma_n^m + \alpha m + \frac{k''n(n+1)}{a_o^2}\, i, \quad a_n^m = \frac{\lambda^*}{\lambda'}\sqrt{\frac{k'}{k^*}\sigma_n^m} + \mu\,\frac{\sqrt{k'}}{\lambda'}\,\sqrt{i}.$$

3. The formulas (15) are suitable for the prognosis of temperature anomalies at any elevation $\underline{z}$ and for any moment of time $\underline{t}$. We tested them in prognoses of the mean monthly values of temperature anomalies at sea level for the entire Northern Hemisphere. These prognoses were made under operational conditions, beginning in May 1958, at the Institute of Applied Geophysics of the Academy of Sciences of the USSR. In each case the initial data date back for 40 days from the beginning of the month for which the anomalies are predicted. The coefficients D_n^m and $D_n'^m$ are determined by using formula (11) and using A_n^m, $A_n'^m$; the latter are found from expansion in series (10) of the initial values of heights of the 600 mb surface for the Northern Hemisphere ($n \leqslant 36$, $m \leqslant 18$).

The parameters α and M should be carefully selected. We drew up all prognoses taking into account only the annual march of α and M, using for each prognosis mean 70-day values of these parameters which had been averaged out in a special way. The remaining parameters in the problem (k', k'', λ', $\lambda*$, $k*$, μ) were taken to be one and the same for all months of the year.

Examples of prognoses are shown in Figure 1 (prognosis for July 1958) and in Figure 3 (prognosis for January 1959). Figures 2 and 4 give the actual corresponding temperature anomalies. The isolines for negative anomalies are denoted by dotted lines in Figures 1 and 2 and by blue lines in Figures 3 and 4.

Is it adequate to represent the meridional transfer of heat by means of the single parameter M in our linear model? A positive, although indirect answer to this question is provided by the correctness of the prognosis both in amplitude and sign. Detailed data will be published separately.

Figure Captions

Fig. 1 Predicted mean monthly anomalies of nonzonal temperatures for July 1958. ($M = 31^{\circ}C$, $\alpha/\omega = 0.030$ -- mean value)

Fig. 2 Mean monthly temperature anomalies -- July 1958

Fig. 3 Predicted mean monthly anomalies of nonzonal temperatures for January 1959. ($M = 78^{\circ}C$, $\alpha/\omega = 0.030 + 0.002$ -- mean value with correction for annual march)

Fig. 4 Mean monthly temperature anomalies. January 1959

("The Hydrodynamic Prognosis of the Mean Monthly Temperature Anomalies for the Northern Hemisphere of the Earth Using IGY Data," by Ye. N. Blinova, Doklady Akademii Nauk SSSR, Vol 131, No 2, 1960, pp. 293-296)

IV. SEISMOLOGY

Distant Quake Recorded by Czech Seismic Station

The seismic station at Pruhonice /50 N, 14.34 E/ is reported to have recorded an earthquake of "catastrophic intensity" on 20 March 1960 at 1719 hours. The epicenter of the disturbance was determined to be in a northeasterly direction from Pruhonice at a distance of 9,000 kilometers. The maximum deviations in ground vibrations measured at the station were 0.5 millimeters. ("Distant Earthquake"; Prague, Obrana Lidu, 22 March 1960, p 2)

V. OCEANOGRAPHY

Zenkevich Reviews the Importance of Marine Microbiology

Professor L. Zenkevich, Corresponding Member of the Academy of Sciences of the USSR, is the author of the following Izvestiya feature article:

Among the works proposed for the Lenin Prize is the book "Marine Microbiology (Deep Water)," written by the Soviet microbiologist Anatoliy Yevseyevich Kriss, published in 1959.

The publication of this book is a great event for the two fields of microbiology and oceanography. Bacteria are extremely small inhabitants of the seas and oceans, invisible to the naked eye; they play a most important role in the biological and biochemical processes taking place in the oceans and constitute the primary food base for many animal organisms living in the oceans. They are also the moving force in the tremendous processes associated with the cycle of carbon, nitrogen, iron, manganese, sulphur, phosphorus, calcium and many other elements in the waters of the ocean and on its bed.

A characteristic of these bacteria is their ability to multiply rapidly, their immense biochemical activity, and rapid development on a massive scale under suitable conditions. Their activity gives rise to whole series of rocks.

Under the influence of these tiny creatures in the seas and oceans there occurs a transformation of organic matter and many processes associated with mineral substances. Hydrogen sulfide contamination of the depths of the Black Sea is associated with the life activity of bacteria. Only the thin surface layer of water of the Black Sea, to a depth of 150-200 meters, is free of hydrogen sulfide and is feasible for the survival of animal life. Deeper down there is a 2-kilometer layer of water contaminated with hydrogen sulfide, with 6 to 7 cubic centimeters of H_2S per liter. This entire supply of hydrogen sulfide is a by-product of the life activity of microspores living on the bottom in immense numbers.

In recent years immense accumulations of iron-manganese concretions have been discovered at the bottom of the Atlantic and Pacific Oceans at depths of 4 to 5 kilometers. These are layered "tablets" 5 to 10 cm in diameter and 3 to 4 cm thick, very heavy, and rusty brown in color. They cover an area of tens of millions of square kilometers in the Pacific Ocean alone. In other words, at the bottom of the Pacific Ocean there are tens of billions of tons of magnificent ore, containing not only iron and manganese, but also copper, nickel and cobalt. The formation of these concretions is the result of the life activity of a whole group of bacteria that possesses the ability to concentrate the elements dissolved in sea water.

Until recently we knew very little about the role played by bacteria in the sea.

Soviet science has played a very important role in the history of microbiology in general and of marine microbiology in particular. Already at the end of the last century and in the first half of the present century the works written by B. Isachenko and V. Butkevich had laid the basis for this essential part of marine biological science.

Professor A. Ye. Kriss is a worthy successor of these scientific traditions. Over a period of twelve years he and a small group of associates on such Soviet marine expeditions as on the "Vityaz," "Ob," "Lomonosov," and on the polar drift stations, have displayed great perseverance and enthusiasm, have followed a single program, and used a unified method for their extensive surface-to-bottom research in the Pacific, Indian and Atlantic Oceans, in the North Polar Basin, and in the waters of Antarctica. As a result, an immense amount of data has been collected and analyzed for the study of marine bacteria on an unprecedented scale. The result has completely justified the effort, time and money expended.

In his voluminous work A. Ye. Kriss gives detailed data concerning the variety of species, quantitative distribution, productivity and biochemical activity of that part of the bacterial population of the seas and oceans which he calls heterotrophic microorganisms.

Especially important is his rather complete and reliable picture of the quantitative distribution of microscopic life in the ocean deeps. The author notes three maxima in the vertical distribution -- surface, deep and bottom. The deep maximum is associated with accumulations of so-called barophilous microbes, adapted to life under conditions of high pressure. The data provided on the quantitative distribution of bacteria are accompanied by very interesting and important information concerning their rate of reproduction.

The book also contains other valuable but more specialized materials.

This work by A. Ye. Kriss is a major contribution to microbiological and oceanographic literature. It opens up broad prospects for the use of his conclusions in further research for the scientific and practical exploitation of the seas and oceans. ("Life of the Ocean Depths," by L. Zenkevich, Izvestiya, 7 April 1960, p 2)

Chinese Publish Study of Tidal Currents in the Gulf of Chihli

Two scientists of the Institute of Oceanology of the Academy of Sciences of the Chinese People's Republic are the authors of an article in the Chinese journal Oceanologia et Limnologia Sinica. The Russian abstract of their article is given below.

This article gives the basis for computing the harmonic constants of the ebb and flow currents of the main waves M_2, S_2, K_1 and O_1 from two diurnal series of observations. On this basis, a harmonic analysis was made for several dozen stations with more than three diurnal series of current observations. Therefore for each station more than three groups of harmonic constants were determined. Then each were individually checked and selected in such a way as to establish a group of harmonic constants conforming with the result of three practical observations. The computation showed that the accuracy of prognosis of ebb and flow currents was up to $\pm 20^\circ$ for direction of flow and up to ± 0.3 knots for velocity.

Preliminary research on the characteristics of ebb and flow currents have shown that in the given region of the sea irregular semidiurnal currents predominate; in the southern part of the Gulf of Liaotung, 40° N., regular semidiurnal currents; in the southern part of Pohai Strait -- irregular diurnal currents

$$\left(2.00 < \frac{W_{K_1} + W_{O_1}}{W_{M_2}} < 4.00\right).$$

These phenomena coincide with the position of the nodes and antinodes of the semidiurnal (M_2) and diurnal (K_1) tidal waves of the sea in question; the distribution of the element of the ellipse of the ebb and flow current of the wave M_2 shows that the given phenomena also have a noticeable regularity in the Pohai Strait between the longitudinal and transverse standing waves. Between the longitudinal standing wave of the Pohai and the transverse standing wave of the northern Yellow Sea there is a mutual interference, the center of rotation of the ebb and flow current. The isoline map of the time at which the maximum velocity of the current sets in shows the full characteristics of rotation. On a tentative basis there is explained the distribution of the isolines for the time in which the maximum velocity of ebb and flow currents set in and the relationship between tidal waves and ebb and flow currents. The viewpoints of Ogura and others are considered incorrect.

Finally, the article gives the basis of the method of the constant tide table prepared by A. I. Dubinin; a permanent tide table of ebb and flow currents in the mentioned sea was compiled on the basis of this method. ("Problems of the Prediction of Ebb and Flow Currents," by Yu Fan-ho and Cheng I-fan, Oceanologia et Limnologia Sinica, Vol 2, No 3, 1959, p 135)

Wind Flow in a Semi-Enclosed Sea

The following is the Russian summary of a 9-page Chinese article:

On the basis of the indicated quantitative method, we examined steady flow under the influence of a stable wind field in the Gulf of Kiaochow.

We used A. I. Fel'zembaum's equation which was applied in respect to the dynamics of marine currents, somewhat abbreviating it, integrating and then introducing a function for full currents.

The function in question was satisfied by the Poisson equation.

An approximate solution was derived by transforming the Poisson equation into an appropriate equation of finite differences, the adoption of a triangular network and the method of relaxation. On the basis of the derived function we derived the field of the wind currents for our region.

The results of computation have demonstrated that under the influence of a northerly wind field at intensity 5, the direction of the surface wind flow in the Gulf of Kiaochow essentially coincides with the wind direction. The maximum velocity of the flow attains about 1 knot. In the near-bottom layer the direction of flow is opposite to the direction of flow of the surface current although the velocity of flow is less. ("Quantitative Computation of the Wind Flow in a Semi-Enclosed Sea," Oceanologia et Limnologia Sinica, Vol 2, No 3, 1959, p 145)

Soviet Oceanological Research in IGY and IGC Reviewed

Soviet oceanological investigations during the International Geophysical Year and International Geophysical Cooperation programs are summarized in an article by N. N. Sysoyev, deputy director of the Institute of Oceanology, Academy of Sciences USSR, which appeared in the February number of the Vestnik Akademii Nauk SSSR for 1960.

The major part of the article presents the principal results of the operations conducted in various parts of the World Ocean during the IGY. The work carried out in 1959 under the IGC has as yet not been fully processed and summated, according to the author, and only certain information on this phase of the operations is presented.

A number of photographs of the ships, ships' laboratories, and personnel engaged in operating some of the many instruments are included. Also included is a chart showing the oceanographic profiles of Soviet ships made according to the IGY. ("Oceanological Investigations of Soviet Scientists," by N. N. Sysoyev; Moscow, Vestnik Akademii Nauk SSSR, No 2, Feb 1960, pp 21-32)

VI. ARCTIC AND ANTARCTIC

Soviet Geographer Reports on Microseismic Snow Subsidence in Antarctica

V. M. Kotlyakov, of the Institute of Geography of the Academy of Sciences of the USSR, is the author of the following text:

In the calm, windless, frozen weather typical of the central areas of Antarctica, it is often possible to hear loud detonations resembling the sound of distant shots. This phenomenon has been noted repeatedly by all the participants on traverses made into the interior parts of the continent.

This type of noise accompanies an irregular settling of the snow mantle. Over great areas of the central part of the continent settling is distinguished by interesting peculiarities. The snow here accumulates very slowly -- the depth of the snow mantle increases by about 20-25 cm yearly. The surface layers of snow are very friable due to the absence of winds. Temperature increases in the upper part of the snow mantle are great -- from -70 or -80° in winter to -20 or -25° in summer. All three conditions lead to a considerable development of the processes of recrystallization and the formation of thick horizons of rotten snow. The snow in such horizons consists of large grains and there are a great many pore spaces: its volumetric weight is less than that of the surrounding snow and its hardness, determined by the extent of the connection between the individual snow crystals, is insignificant. With the passage of time such horizons extend to a depth of several meters from the surface, with considerable pressure from the snow above. Thus, at a depth of 6 m the pressure exceeds 0.25 kg/cm^2 and the hardness here is greater than in the individual disintegrating horizons. Under such conditions the gradual and even settling process is suddenly disrupted by a snow avalanche with a collapse of the original structure and this is accompanied by a noise similar to that of a shot.

Such a phenomenon has been observed repeatedly in central Greenland where there have been cases when a shock has been recorded simultaneously at different stations 500 km apart. This means that the waves generated by snow collapse occurring at a given point are instantly propagated through the snow for hundreds of kilometers. True, although it extends over great areas it takes place only in a thin layer of snow, 10 to 20 cm thick.

It has become clear that this phenomenon of settling is also widespread in Antarctica. A special instrument -- an automatic subsidence meter -- was placed in a layer of snow at the station of Pionerskaya. It recorded a number of shocks in the snow during which the even subsidence curve was interrupted, the pen of the automatic recording device moving upward, thereby marking a sudden settling of 1-2 cm. Such shocks were recorded on 14 April, 21 May, 6 and 18 August and 25 September 1957. They could not have been the result of earthquakes, for example, because the seismographs at Mirnyy did not show any special deviations from the norm at this time.

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Sudden snow subsidence was also incidentally noted during the course of other work with precise instruments that had been embedded in the snow. We often noted the consequences of such snow collapse when analyzing snow profiles in test pits. In such cases we encountered snow horizons that were sharply distinguished by an uneven density and irregular structure. They were made up of large crystals of deep rime-like material characteristic of horizons that had undergone disintegration. In most cases snow collapse accompanying the settling of a snow layer usually occurs in a range of 4 to 7 meters from the surface.

("Snow Collapse in Antarctica," by V. M. Kotlyakov, Priroda, No 3, March 1960, pp 110-111)

Report on Round-the-World Cruise of the Research Vessel Ob'

Izvestiya of 7 April carries the following feature story:

Yesterday in the Atlantic south of the Canary Islands the diesel electric ship Ob', flag-ship of the Soviet Antarctic Expedition, completed an unprecedented round-the-world voyage; a large part of its route was around the Antarctic continent.

"1300 hours Moscow time. Latitude 23°44' N., Longitude 17°01' W. Course -- north."

The Ob' was situated at these very same coordinates on 23 November 1959 -- 136 days earlier. Each page in the thick bound logbook carries the entries of a single day. Let's mentally page through these 136 pages -- from one end of the log to the other. Here's a date -- 23 November "1620 hours Moscow time. Latitude 23°44' N., Longitude 17°01' W. Course -- south. Wind northwest at intensity 4-5, cloudiness -- 5, temperature +20°".

Yesterday there was approximately the same weather at this point, but for the 136 days of the voyage there were winds of gale and hurricane force, heavy coatings of ice, icebergs, blinding fogs, and snow storms. Nature used every force at her disposal to test the will and perseverance of the people proudly bearing the flag of their Motherland around the entire sixth continent.

The correspondent of "Izvestiya" communicated by radio with the ship and asked for a brief report as to what transpired on this unprecedented voyage. Captain Aleksandr Iosifovich Dubinin and the expedition chief, Professor Igor' Vladislavovich Maksimov, responded to the inquiry from aboard the Ob'.

The fifth Antarctic voyage of the Ob' progressed almost entirely amidst continual storms; two of these storms -- in the Bay of Biscay and in the South Atlantic -- proved to be exceptionally severe. The rolling of the ship was so great that the ship listed more than 40 degrees and the situation nearly became critical. Cabinets and lockers broke loose from the walls in the cabins and a heavy dental chair broke loose from its lashings in the infirmary. Huge waves frequently swept over the ship and the crew was hard pressed to save the freight on deck, especially the planes.

On this cruise the Ob' went first to the recently established Soviet scientific station at Lazarev in Queen Maud Land instead of to Mirnyy. Enroute to Lazarev the vessel sailed for 800 miles amidst the ice, 200 miles in pack ice.

The voyage to the Japanese station Showa was of exceptional difficulty; near this point the Ob' rendered assistance to the ice-blocked Japanese ice-cutter "Soyya" (Russian transliteration). The Ob' thereafter headed for the Australian station Mawson and, as in the previous year, was the first vessel to arrive; the "Tala Dan," the ship of the Australian expedition, had only departed from Melbourne on that same day.

At Mirnyy, at an unexpectedly wide and solid zone of floe ice, the participants of the Soviet maritime expedition met up with the diesel vessel "Kooperatsiya"; the latter vessel had transported the fifth team of workers of the Soviet continental expedition to Antarctica but it could not make its way to the Pravda Coast. Twelve days of continual and enervating work were required to break an 8-mile long channel through the pack ice to the point for unloading of ships at a tidal opening near Haswell Island. On the other hand unloading operations proceeded routinely and were completed in six days.

On 1 February the Ob' headed eastward along the Antarctic coast. This was for the purpose of undertaking a new and responsible mission -- to meet up with the flotilla consisting of the "Slava" and "Sovetskaya Ukraina" and take part of their cargo of whaling products back to the Motherland. The reloading of the whale oil into the holds of the Ob' was complicated and risky. The ships lay at drift, side by side, and were subjected to heavy rolling. When one vessel rose on the crest of a wave, the other plummeted downward. From time to time a squall of hurricane force blew up suddenly and the waves immediately surged higher. The voices of the men were lost in the wild confusion of sounds. Shouted orders went unheard. The strongest of caprone ropes snapped like threads. The carcasses of whales that had been placed between the ships to serve as "fenders" did not keep the vessels from striking against one another.

Finally, due to the joint efforts of the seamen and whalers, the Ob' was completely loaded and proceeded on its voyage around Antarctica. The entire voyage of the vessel was made in the high latitudes, south of the 65th parallel and in the Ross, Amundsen and Bellingshausen Seas, even south of the Antarctic Circle. To all intents and purposes this was the first such voyage ever made. For the first time a bold enterprise had been undertaken and carried to completion -- Antarctica had been circumnavigated in a single voyage in the high latitudes in the immediate vicinity of the icy shores of the continent. The voyage is therefore of the greatest scientific interest.

Ice reconnaissance and radar surveys yielded completely new facts about the ice belt around Antarctica and about the manner in which icebergs are carried out into the ocean. It is now clear that there is no continuous belt of floating ice surrounding the entire continent. Ice was only encountered in the several regions influenced by the cyclonic circulation of waters in the ocean. In other parts of the coastal zone the belt of marine ice was confined directly to the shores of the continent.

Much was also learned about the distribution of icebergs along the periphery of Antarctica. They are carried into the ocean only in a few regions where extraordinary "iceberg rivers" flow to the north. The Ob' encountered virtually no icebergs in other places along its route.

Observations of currents in Antarctic waters also yielded very interesting results. These observations by the Soviet expedition were made by using modern electromagnetic methods. A comparison of these observations with data recorded in past years has once again shown that the so-called westerly wind current surrounding all the periphery of Antarctica -- a current approximately eight times greater than the Gulf Stream -- was noticeably weaker this year. A comparison of this fact and the data of other observations enables us to conjecture that a cooling process has now begun in Antarctica, as well as in the Arctic.

Additional processing of the data collected by the expedition will yield much new and interesting information about the nature of the oceans surrounding Antarctica. ("A Ring of Ice," by O. Stroganov, Izvestiya, 7 April 1960, p 4)

Turboprop Flights Service Bases in the Arctic

"On 5 and 6 April the turboprop airliner 'AN-10' successfully accomplished its first two flights in the Arctic and made landings on the drift ice of the Central Polar Basin. The crew of airmen of the polar aviation units of the Civil Air Fleet delivered 17 tons of vitally important freight from an icebound airdrome on the mainland to the scientific station SP-8."

"Both landings were masterfully executed by the plane commander V. Vasil'yev and the copilot G. Bardyshev. Simple but ingenious apparatus in the fuselage of the aircraft made it possible to unload the plane on the ice floe in fifteen minutes."

"At a press conference held yesterday in the office of the Chief of Polar Aviation of the Civil Air Fleet (Hero of the Soviet Union M. I. Shevelev) it was estimated that the capacity of the turboprop liner for transport operations in the Arctic is several times greater than for aircraft of the 'IL-14' type." ("Turboprop Giant Over the Arctic," Izvestiya, 7 April 1960, p 4)

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